X-Ray Radiography

Capabilities/Facilities

Digital radiography facilities include a variety of detector systems, including scanning linear arrays, 2D area detectors, and real-time-imaging capabilities. Spatial resolution on the order of 15-30 mm for small particles or higher resolution for larger objects. Imaging and image-processing capabilities for detection and evaluation of defects in large volumes of particles.

Computed tomography (CT) systems with resolution on the order of tens of microns for small particles can be used to detect defects, density variations and delaminations, as well as for metrology. Capabilities include commercial fan-beam scanners and reconfigurable laboratory systems, including first generation systems for density/material identification, 3D fan beam (spiral CT) for objects up to 700 mm in diameter, and 3D cone beam systems capable of scanning objects ranging in size from 1 mm to 1 m.

Other capabilities include high-energy X-ray fluorescence (XRF) imaging for material identification (point measurements or CT), and low energy XRF and phase-contrast imaging a using laser-Compton X-ray source in collaboration with Idaho State University.

Materials

Containerized waste, unexploded ordinance, coated fuel particles.

Scientific/Engineering

Issues

- High-spatial resolution and high-contrast resolution imaging
- Detection and visualization of small voids, density defects, delaminations
- Tomographic reconstructions from limited-angle data sets
- Detection and visualization of flow pathways through porous media.

Staff

T.J. Roney, T.A. White, R.J. Pink, K.M. Wendt, and M. Smith (Idaho State University).

Recent Projects

"Field-Portable X-ray Imaging Systems" (U.S. Army)—Developing the capability to bring high-resolution digital radiography and CT systems out of the lab and to the part that is to be examined. Systems capable of examining objects as large as 85-gallon drums have been developed and used for unexploded ordinance and hazardous-waste remediation tasks.

"Laser-Compton X-Ray Source and Accelerator-Based XRF (AXRF) Imaging" (Laboratory-Directed Research and Development)—Development of a tunable, monochromatic, hard X-ray source that does not require a synchrotron. This source generates X-rays from the interaction of a laser beam and a high-energy electron beam. The X-rays from this source should be very useful for imaging low-contrast materials and for material identification, e.g., in the detection and quantification of leakage/distribution of uranium outside the kernel of a fuel particle.

Collaborations

Medical Imaging Research Laboratory, University of Utah (Dr. Frederic Noo, Dr. Rolf Clackdoyle)—Novel data-collection geometries and reconstruction algorithms for fan- and cone-beam computed tomography, reconstruction of data acquired with limited-angular sampling, region-of-interest imaging.

Idaho Accelerator Center, Ida-

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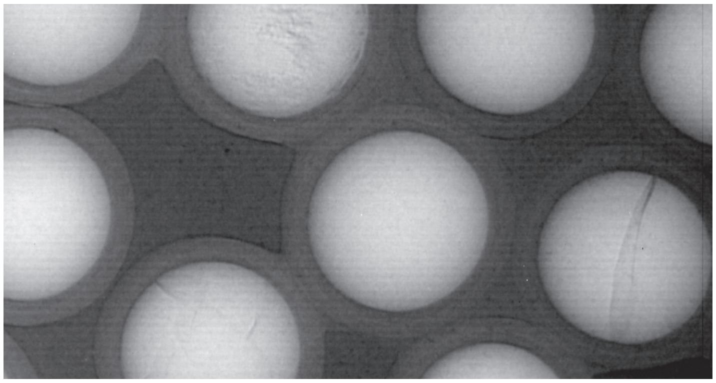

A portion of a radiograph of surrogate fuel particles. These particles have a high-density core and two thin outer layers. Defects can be seen in many of the particles.

For more information

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ho State University (Dr. Frank Harmon, Dr. Doug Wells, Dr. Alan Hunt)—Accelerator-based X-ray fluorescence for examination of radioactive/hazardous waste, novel detectors for emission/transmission X-ray imaging.

Publications

"Doppler Broadening Measurements of Positron Annihilation using Bremsstrahlung Radiation," F.A. Selim, D.P. Wells, J.F. Harmon, W. Scates, J. Kwofie, R. Spaulding, S.P. Duttagupta, J.L. Jones, T. White and T. Roney, *11th International Positron Conference,* Santa Fe, NM, July, 2001. (Accepted for publication in *Nucl. Instr. Meth. B*, 2002.)

"Development of Accelerator–Based X-ray Fluorescence for Large Sample Assay," D.P. Wells, F.A. Selim, J.F. Harmon, W. Scates, J. Kwofie, R. Spaulding, S.P. Duttagupta, J.L. Jones, T. White and T. Roney, *40th International Denver X-ray Conference,* Steamboat Springs, CO, July 2001. (*Advances in X-Ray Analysis*, Vol. 45, 2002.)

"Development of Bremsstrahlung-based Positron Probe for Assay and Defect Analysis," F.A. Selim, D.P. Wells, F.J. Harmon, J. Kwofie, W. Scates, R. Spaulding, G. Erickson, S.A. Parke, S.P. Duttagupta, J.L. Jones, T. White and T. Roney, *1st Inland Northwest Research Alliance Conference on Sub-surface Science*, 2001.

"Accelerator-Based XRF for Subsurface Science," J. Kwofie, D.P. Wells, F.A. Selim, F. Harmon, W. Scates, R. Spaulding, G. Erickson, S.A. Parke, S.P. Duttagupta, J.L. Jones, T. White and T. Roney, *1st Inland Northwest Research Alliance Conference on Subsurface Science*, Aug. 2001.

"Characterization of RH-TRU and Lead-Lined Drums Using X-Ray Imaging Techniques," T.J. Roney and T.A. White, INEEL report INEEL/EXT-2001-00625.

"Estimation of Geometrical Parameters in Spiral CT," F. Noo, T.A. White, R. Clackdoyle, and T.J. Roney, *IEEE Medical Imaging Conference*, October 2000.

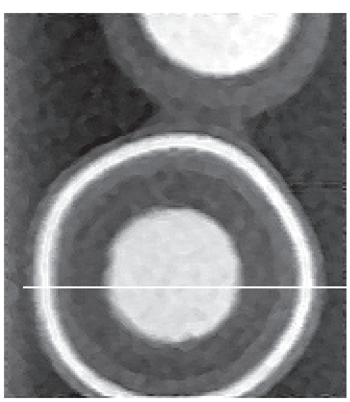
"Comparison of Fan-and Cone-beam Imaging Capabilities on a Portable X-ray Imaging System," T.A. White, T.J. Roney, R.J. Pink, M. Smith, R. Clackdoyle, and F. Noo, *SPIE International Symposium on Optical Science, Engineering, and Instrumentation, July 1999.*

"Portable Gamma-Ray Transmission System for Identification of Chemical Agents," T.J. Roney, T.A. White, R.J. Pink, M. Smith, and W. Jones, *SPIE International Symposium on Optical Science, Engineering, and Instrumentation*, July 1999.

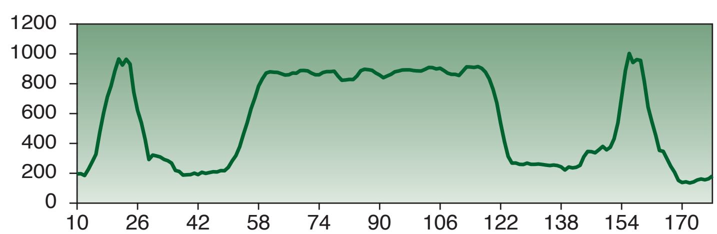
"Noniterative Methods for Scanner Calibration in Cone-Beam Tomography," F. Noo, C. Mennessier, R. Clackdoyle, T.A. White and T.J. Roney, *International Meeting on Fully Three-Dimensional Image Reconstruction in Nuclear Medicine and Radiology*, June 1999.

"The Dual-Ellipse Cross Vertex Path for Exact Reconstruction of Long Objects in Cone-Beam Tomography," F. Noo, R. Clackdoyle, T.A. White, and T.J. Roney, *Physics in Medicine and Biology*, IOP Publishing Ltd., 43 (1998) p. 797.

"Conebeam Micro-tomography Using a Fiber-optic Scintillator and a Lens-Coupled CCD Camera," T.A. White, T.J. Roney and S.G. Galbraith, *Review of Progress in Nondestructive Evaluation 16B*, D.O. Thomson and D.E. Chimenti, eds., p. 2159, 1997.



Tomographic slice through a surrogate fuel particle with four outer layers and a dense central core.



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